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Rodgers, Jr.

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(54) **CRANK SYSTEM ASSEMBLIES AND METHODS FOR USE THEREOF**

(76) Inventor: **Robert E. Rodgers, Jr.**, 974 Kings Point Dr., Canyon Lake, TX (US) 78133

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This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**
A63B 22/04 (2006.01)
A63B 22/06 (2006.01)

(52) **U.S. Cl.** **482/52**; 482/51; 482/57

(58) **Field of Classification Search** 428/51–53, 428/57–65, 70, 79–80
See application file for complete search history.

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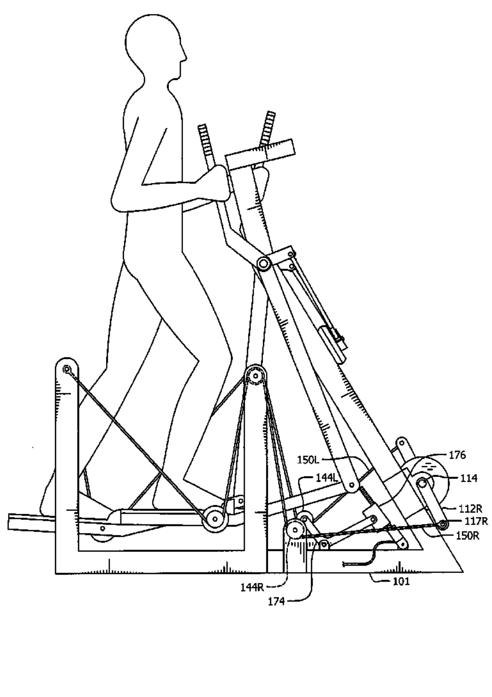
Primary Examiner—Steve R Crow
(74) *Attorney, Agent, or Firm*—Fulbright & Jaworski L.L.P.

(57) **ABSTRACT**

An exercise apparatus comprises: a frame; a crank system supported by the frame; a right and left foot members supported by the frame; first and second flexible element coupled to the crank system and foot support members such that downward motion of either foot support member causes rotation of the crank system; and a crank offset assembly configured to prevent the crank system from becoming locked at a top dead center location.

39 Claims, 11 Drawing Sheets



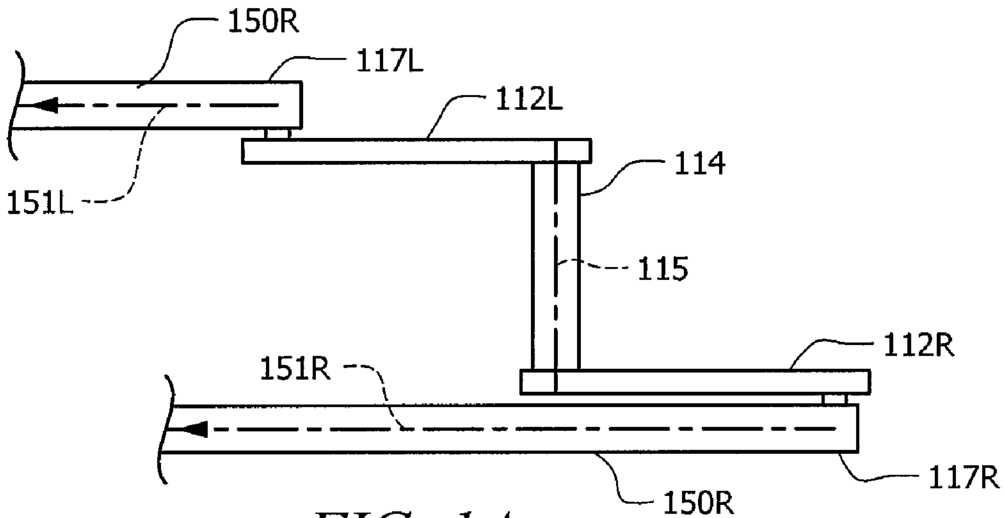
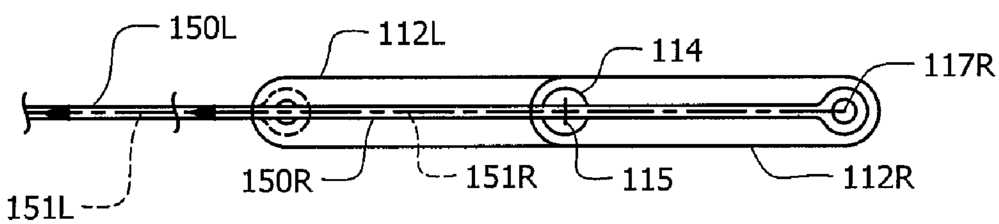

150R
117L
112L
114
151L
115
112R
151R
117R
150R

FIG. 1A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112R
151L

FIG. 1B

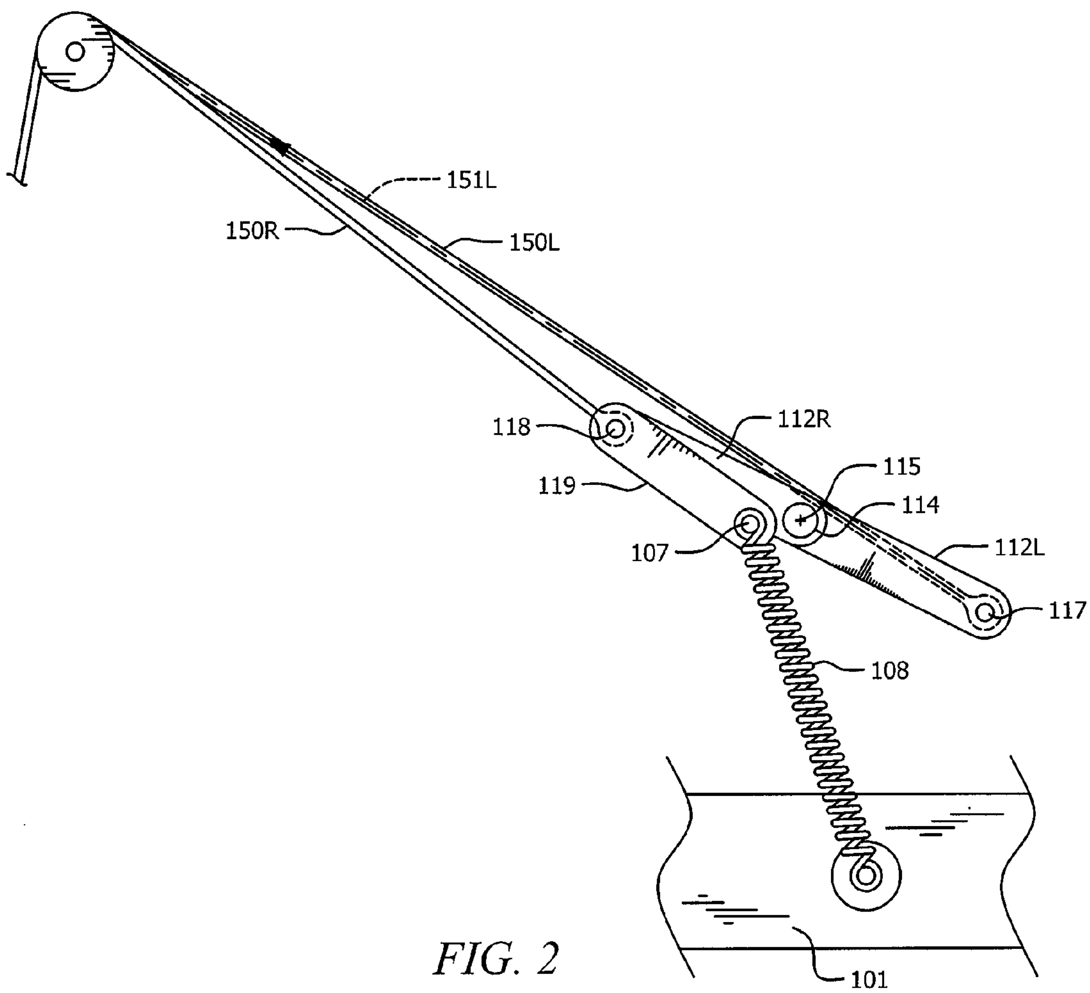


FIG. 2

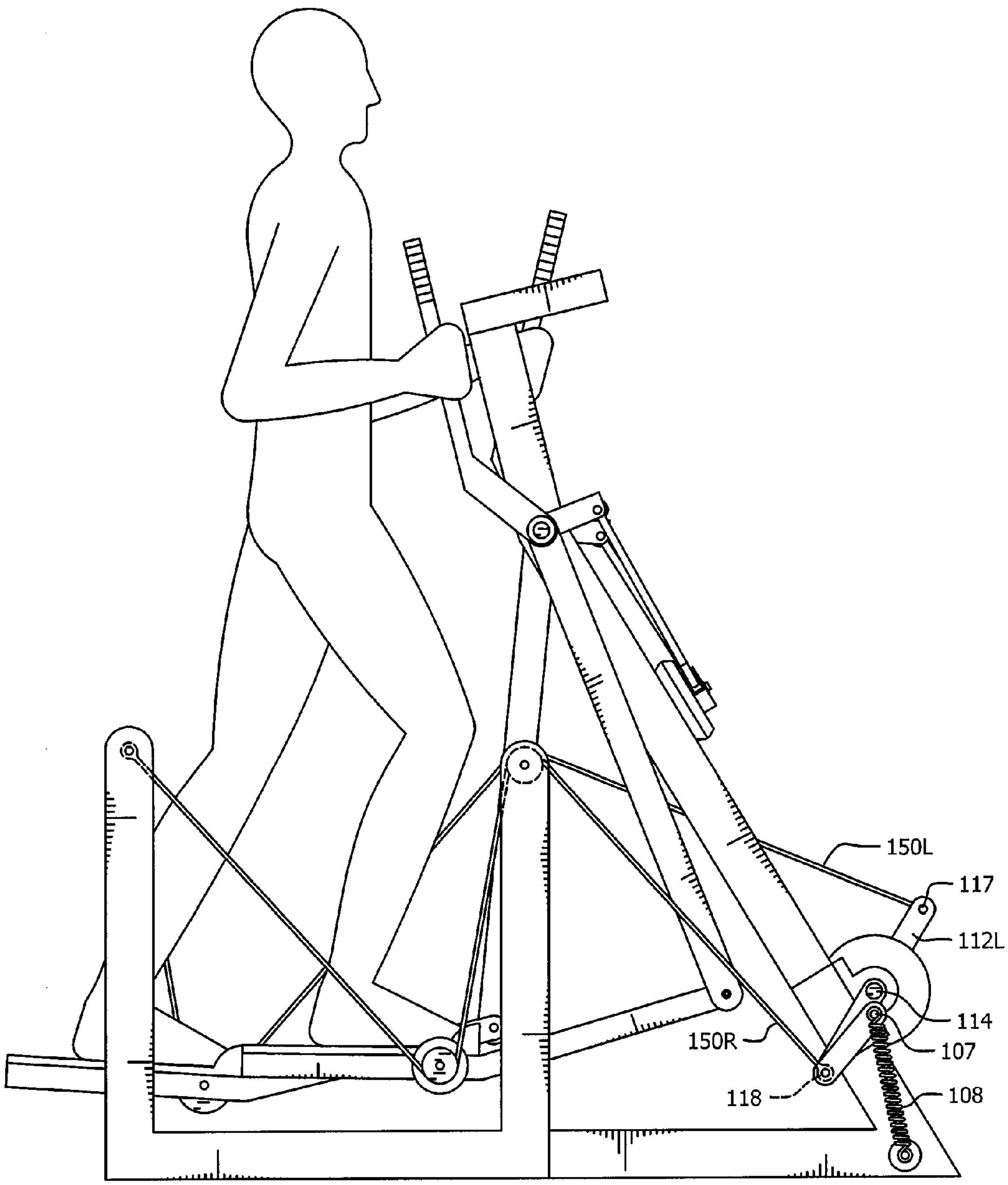


FIG. 2A

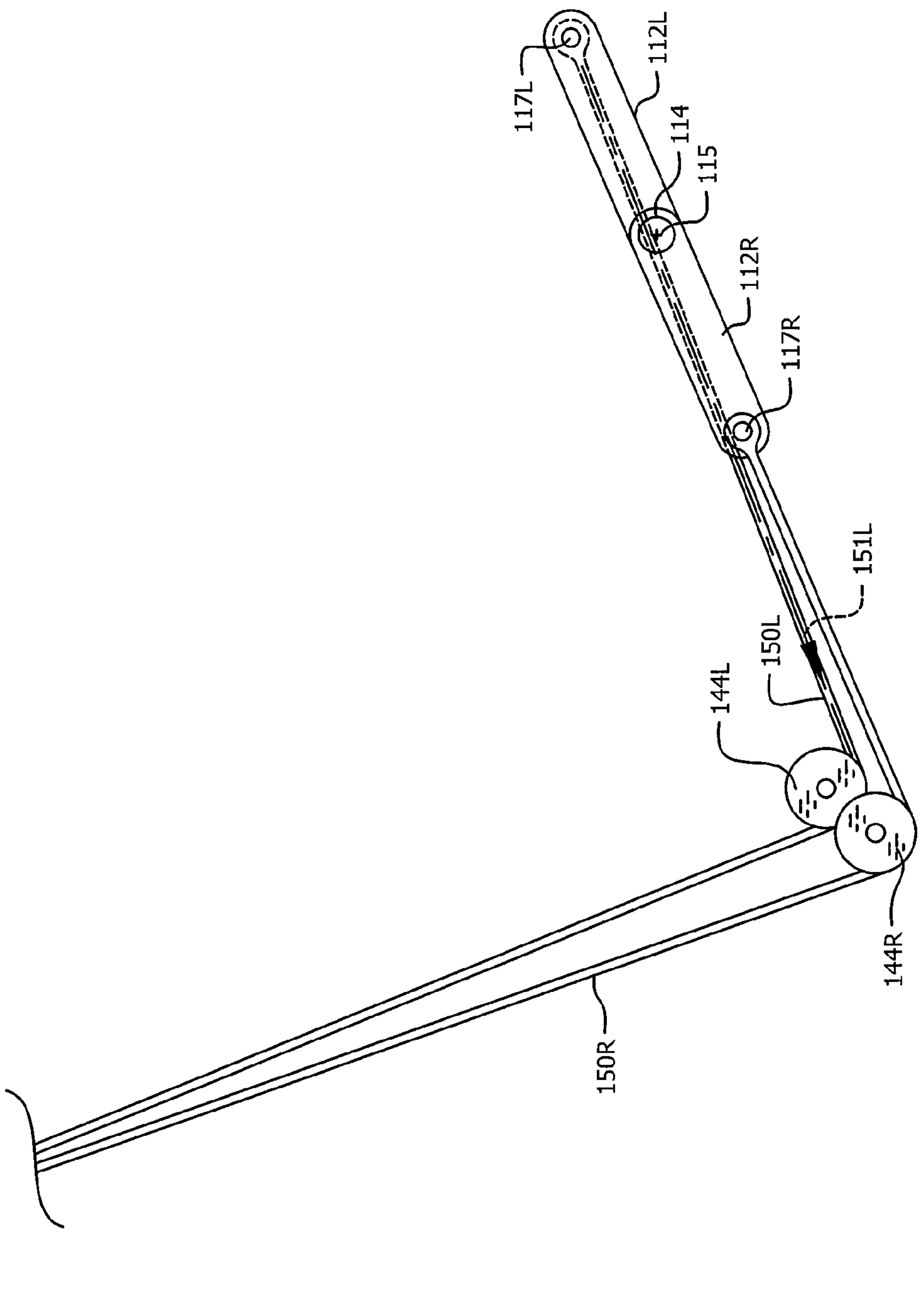


FIG. 3

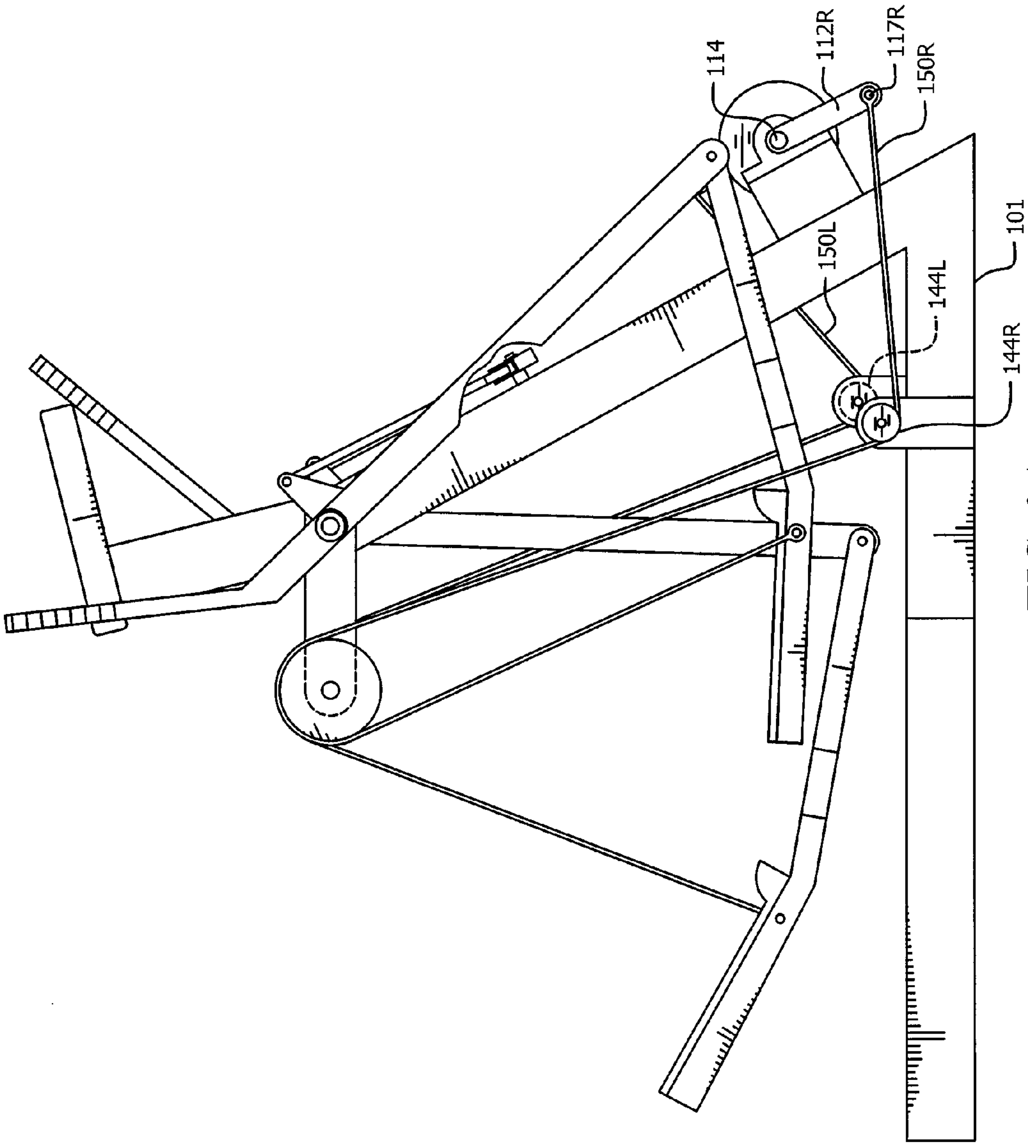


FIG. 3A

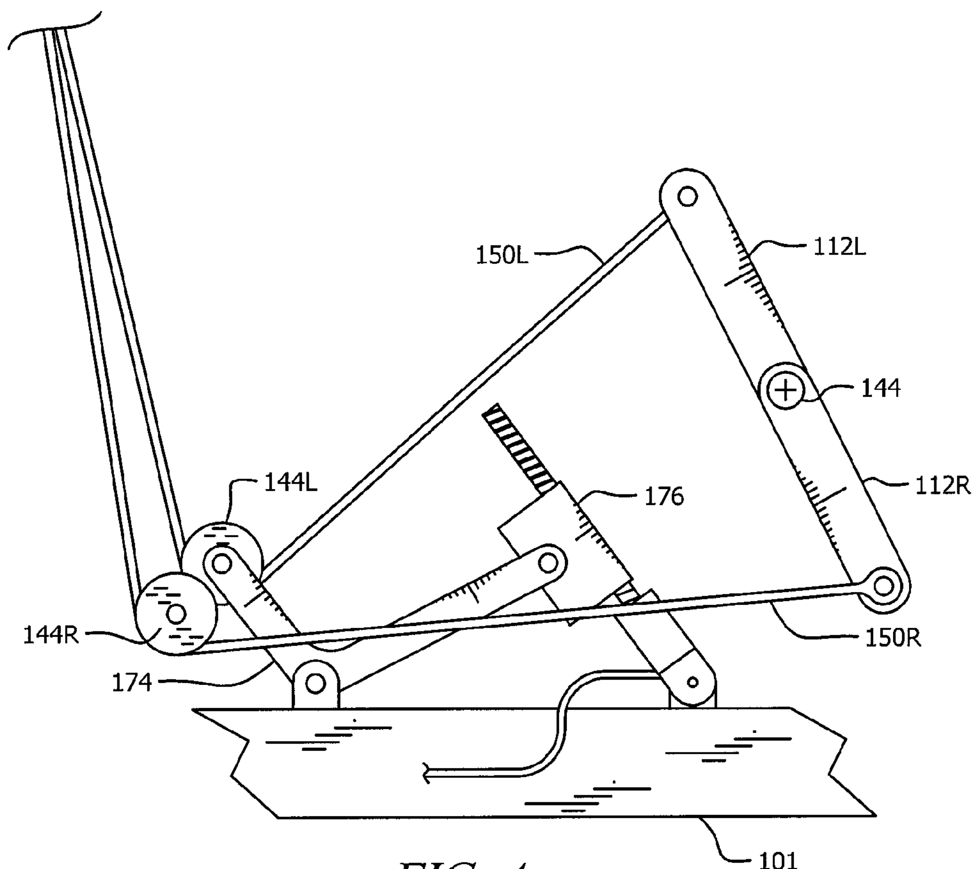


FIG. 4

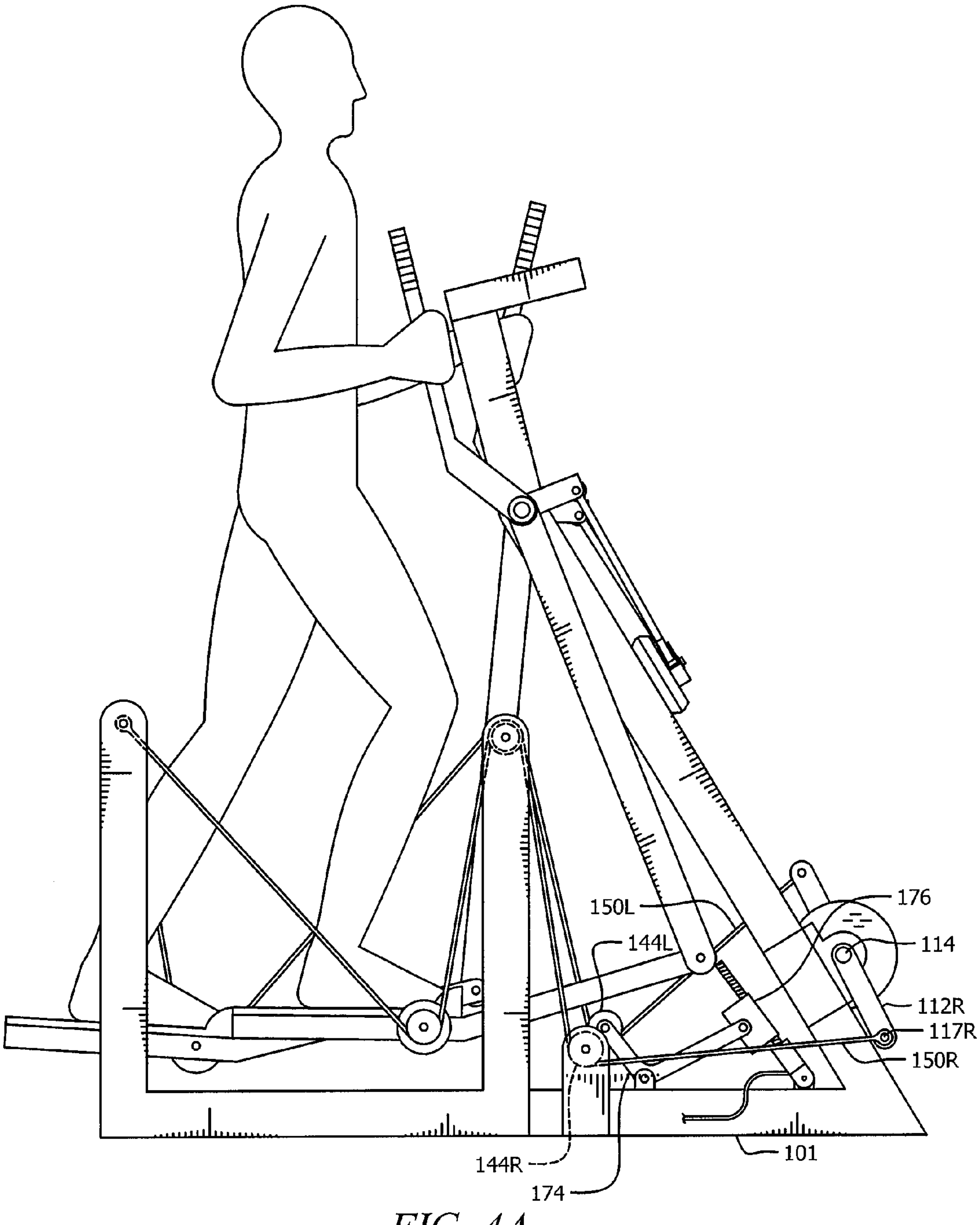


FIG. 4A

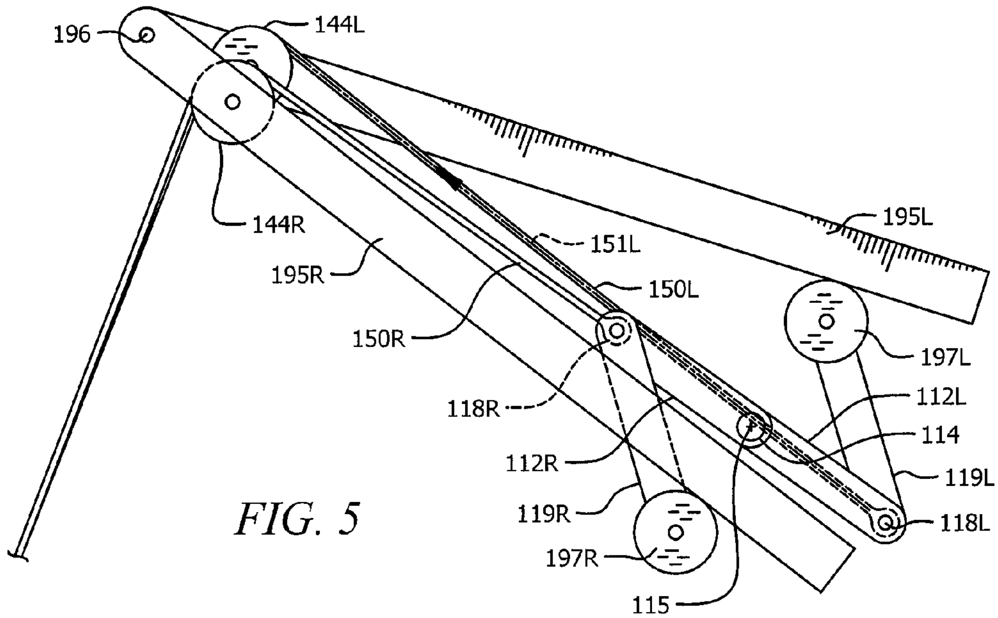
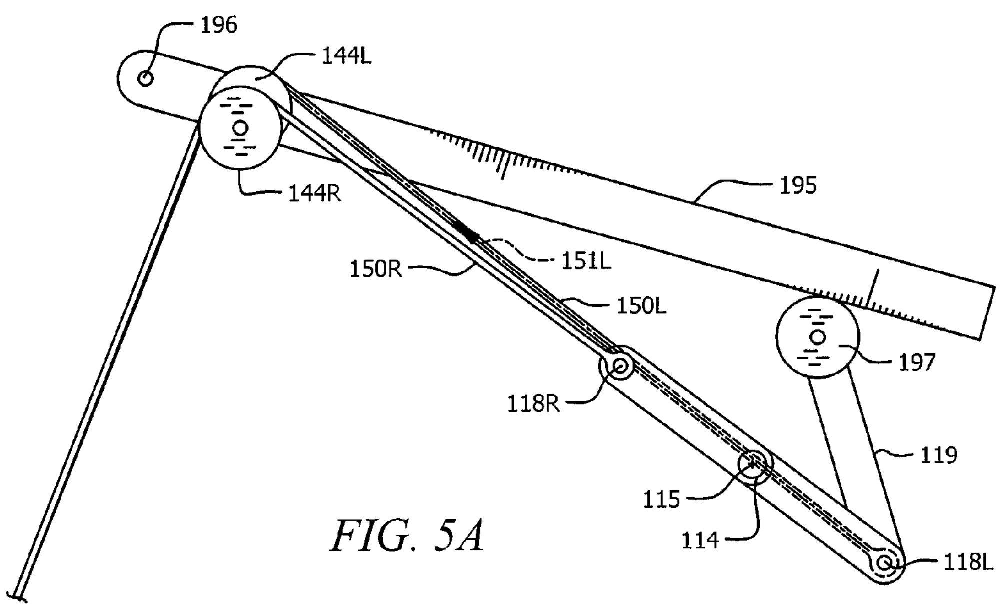

196
144L
144R
195L
151L
195R
150L
150R
197L
118R
112L
114
112R
119L
119R
118L
197R
115

FIG. 5


196
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144R
195
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150L
197
118R
119
115
114
118L

FIG. 5A

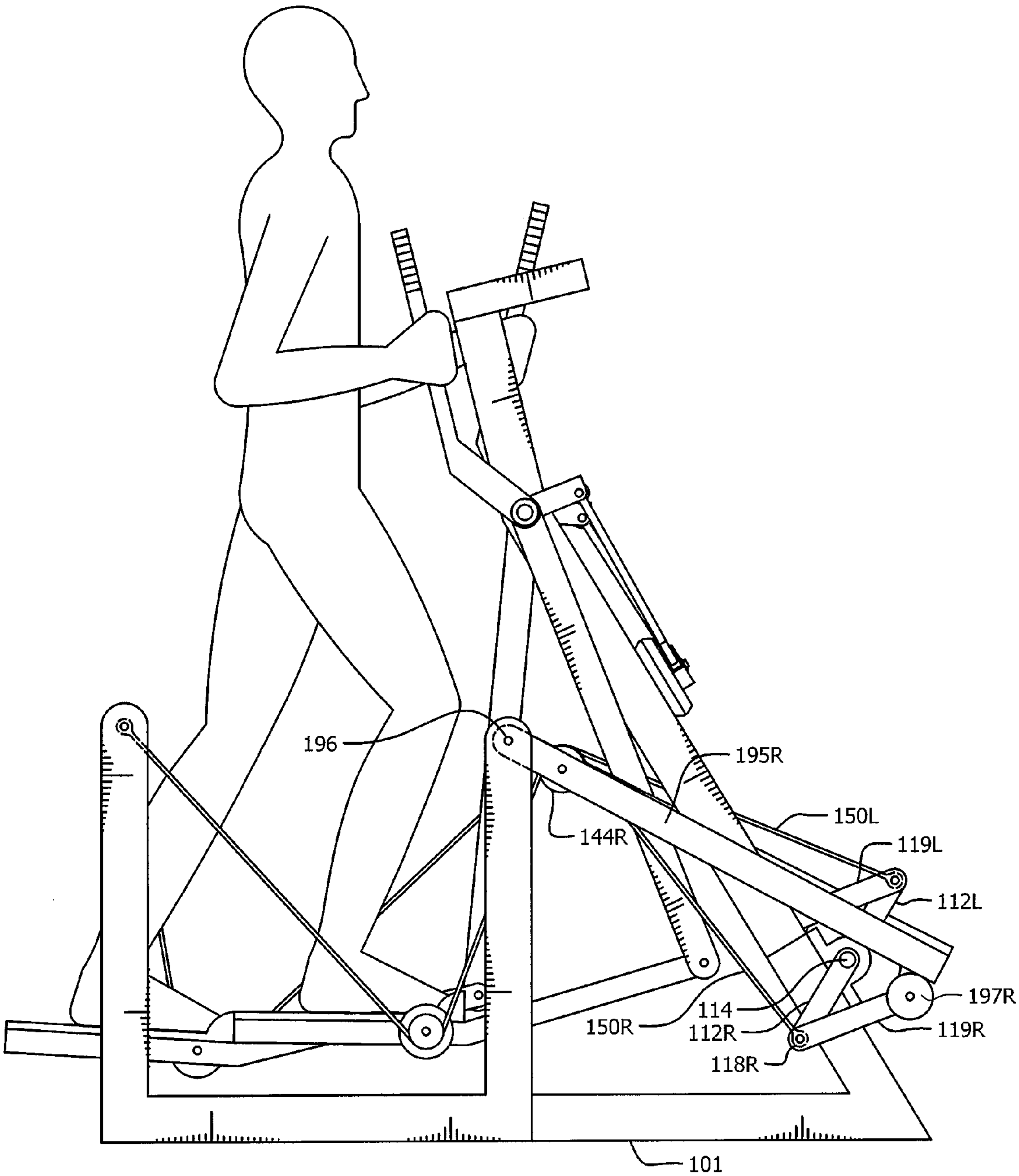

FIG. 5B

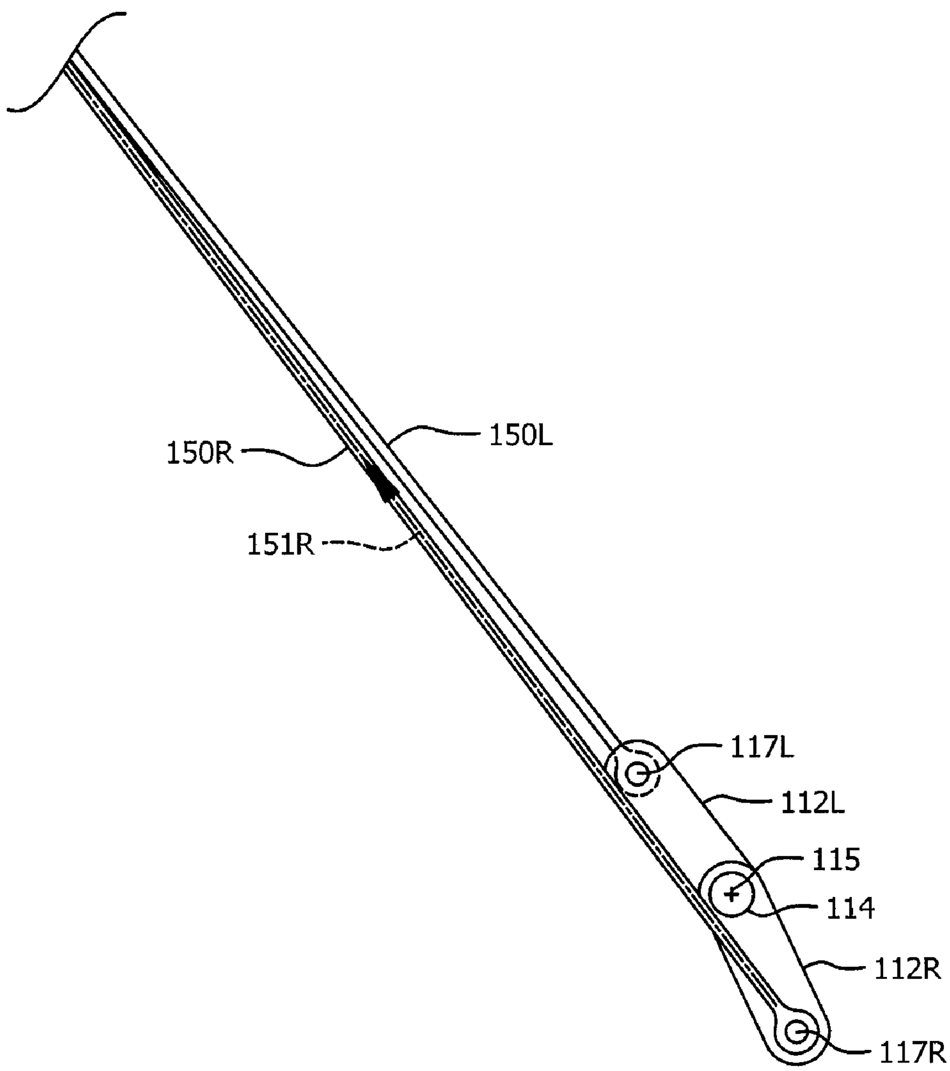

FIG. 6

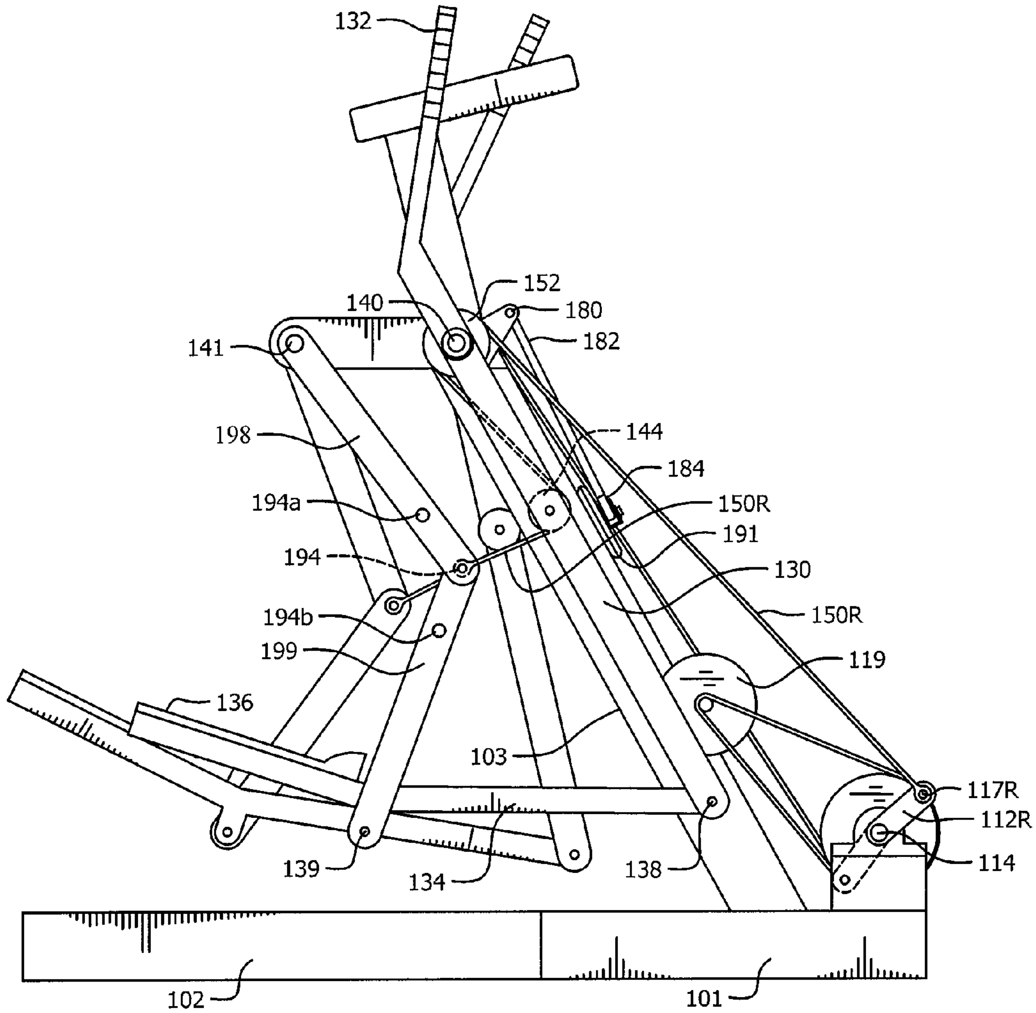
132
152
140
180
141
182
198
144
184
194a
150R
191
194
130
194b
150R
199
119
136
103
117R
112R
114
139
134
138
102
101

FIG. 6A

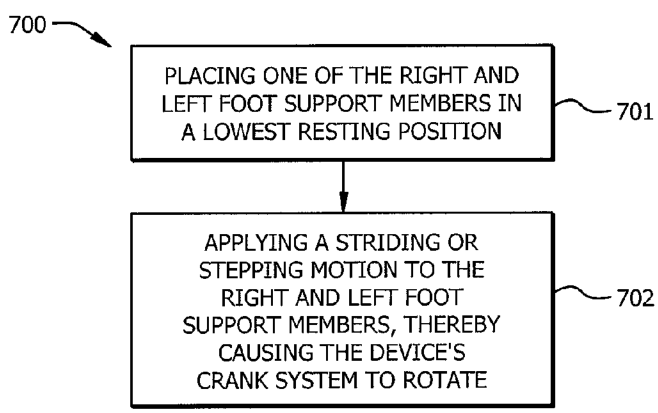
700
PLACING ONE OF THE RIGHT AND LEFT FOOT SUPPORT MEMBERS IN A LOWEST RESTING POSITION
701
APPLYING A STRIDING OR STEPPING MOTION TO THE RIGHT AND LEFT FOOT SUPPORT MEMBERS, THEREBY CAUSING THE DEVICE'S CRANK SYSTEM TO ROTATE
702

FIG. 7

CRANK SYSTEM ASSEMBLIES AND METHODS FOR USE THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application 60/928,619, filed May 10, 2007 and entitled "LINKAGE AND CRANK SYSTEMS" and to U.S. Provisional Patent Application 61/072,564 filed Apr. 1, 2008 and entitled "LINKAGE AND CRANK SYSTEMS", the disclosures of which are hereby incorporated herein by reference.

TECHNICAL FIELD

The present description relates generally to crank systems for exercise devices and, more particularly, it relates to crank system assemblies for flexible element exercise devices.

BRIEF SUMMARY OF THE INVENTION

Various embodiments of the invention relate to crank systems offset assemblies that prevent crank lockup in flexible element exercise devices. In one example, a spring is coupled to a journal in a crank system to provide a displacing force.

In another example, guide elements are positioned asymmetrically.

In another example, guide elements can be repositioned.

In another example, a linkage system is coupled to the crank system. The linkage system comprises guide elements for the flexible elements. Interaction of the crank system and linkage system causes displacement of the guide elements.

In another example, the crank system has asymmetric geometry.

An exercise device according to the present invention may be used to create offset between flexible element tension vectors and a crank system axis. Such offset can prevent lock up of the crank system.

The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims. The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will become fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views, and wherein:

FIG. **1** depicts a top and side view of a simple crank system;

FIG. **2** depicts a side view of an example embodiment of a crank system adapted according to an embodiment of the present invention;

FIG. **2**A depicts a side view of an example flexible element exercise device incorporating the embodiment of FIG. **2**;

FIG. **3** depicts a side view of an example embodiment of a crank system adapted according to an embodiment of the present invention;

FIG. **3**A depicts a side view of an example flexible element exercise device incorporating the embodiment of FIG. **3**;

FIG. **4** depicts a side view of an example embodiment of a crank system adapted according to an embodiment of the present invention;

FIG. **4**A depicts a side view of an example flexible element exercise device incorporating the embodiment of FIG. **4**;

FIG. **5** depicts a side view of an example embodiment of a crank system adapted according to an embodiment of the present invention;

FIG. **5**A depicts a side view of an example embodiment of a crank system adapted according to an embodiment of the present invention;

FIG. **5**B depicts a side view of an example flexible element exercise device incorporating the embodiment of FIG. **5**;

FIG. **6** depicts a side view of an example embodiment of a crank system adapted according to an embodiment of the present invention;

FIG. **6**A depicts a side view of an example flexible element exercise device incorporating the embodiment of FIG. **6**; and

FIG. **7** is an illustration of an example method adapted according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description, reference is made to the accompanying drawings, in which are shown by way of illustration specific embodiments of the present invention. It should be understood that the detailed description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the invention. Numerous changes, substitutions, and modifications may be made without departing from the scope of the present invention.

Exercise devices that utilize flexible elements are described in U.S. Patent Application Publication Nos. US 2006/0217234 A1 by Rodgers, Jr., US 2007/0219061 A1 by Rodgers, Jr., and US 2007/0219062 A1 by Rodgers, Jr., each of which is incorporated by reference as if fully set forth herein. These referenced applications describe flexible element exercise devices that utilize flexible elements coupled to crank systems and foot support members. Users of these flexible element exercise devices may cause rotation of the crank systems by undertaking stepping or striding motions. The right side foot support member may be coupled through a first flexible element to a first crank arm, and the left foot support member may be coupled through a second flexible element to a second crank arm. If a crank system with similar sized and shaped crank arms is utilized in a flexible element exercise device, crank lock up may occur in certain circumstances. For example, if the user ascends the flexible element exercise device and puts most of his/her weight on the right foot support member for a short time, the first flexible element will pull the first crank arm to a bottom dead center location. In a traditional crank system design, this situation places the opposing second crank arm at a top dead center location.

When the user transfers weight to the left foot support member to initiate exercise, the second flexible element will apply force to the second crank arm which is at a top dead center location. The crank system will be locked and unable to rotate. In the above referenced applications, a counterweight is utilized to prevent the crank system from settling into a top dead center location.

FIG. **1** shows a top view and a side view of an example of a simple crank system with flexible elements. Right and left crank arms **112**R and **112**L are coupled to crank shaft **114**. As used herein, the term "coupling" or "coupled" includes a direct coupling or an indirect coupling. The crank system has a crank system axis **115** which is the effective axis about which the crank system rotates. The crank shaft **114** would typically be supported by rotational bearings which are not shown. Right and left flexible elements **150**R and **150**L are coupled to right and left crank arms **112**R and **112**L at crank system coupling locations **117**R and **117**L. Crank arms **112**R and **112**L have mirror symmetry when viewed from the side, i.e. down the crank system axis, and crank system coupling locations **117**R and **117**L are located at 180 degrees relative to each other with the crank axis serving as the origin of measurement.

The simple crank system of FIG. **1** is widely used, but a crank system may be of other configurations yet have similar or identical function. A crank system will typically have an axis of rotation and coupling locations away from the axis so that force applied at the coupling locations creates torque and rotary motion about the axis. As an example, a crank system could have multiple arms. Alternately, a crank system could be a disc with a central shaft and with coupling locations near the periphery which effectively act as crank arms. Alternately, a crank system could be a ring supported by rollers; the ring could have coupling locations near the periphery which effectively act as crank arms. Alternately, certain planetary gear systems may function as a crank system having a crank system axis and coupling locations near the periphery.

If in FIG. **1** continuous tension is applied to flexible element **150** L, crank arm **112**L will align with the applied tension vector, which is represented by the center line and arrow **151** L. For the purposes of this application, a tension vector is a line that defines the direction of tension in a flexible element. The tension vector may project beyond the flexible element as it is defining direction. The tension vector will generally pass through the flexible element, but its exact location relative to the cross section of the flexible element is typically affected by the type and construction method of the flexible element. The tension vector is shown in the center of flexible element **150**L, and for purposes of this discussion the tension vector is analyzed for that portion of the flexible element near the crank system.

In one example, the application of continuous tension occurs when a user pauses while using a flexible element exercise device. During such a pause, the user may apply the majority of his/her weight to one foot support member which in turn applies greater tension to the flexible element coupled to that foot support member. The foot plate on the foot support member will then go to its lowest resting position. In this simple crank system, during such a pause with the foot plate at its lowest resting position, tension vector **151**L will intersect crank system axis **115** (shown as a line running through crankshaft **114** lengthwise—it is also the axis of rotation of the crank system). The intersection of crank axis **115** and tension vector **151**L creates a bottom dead center condition for crank arm **112**L and a top dead center condition for crank arm **112**R.

The terms "top" in "top dead center" and "bottom" in "bottom dead center" do not necessarily describe the physical location in space of the crank arms, but rather the geometric positioning of the crank arms and coupling locations in relation to the flexible elements, crank system axis, and tension vectors. Depending on the structure of the flexible element exercise device, a crank arm that may be in a "bottom dead center" location may be physically located above or level with the opposing crank arm. Further, a crank arm that may be in a "top dead center" location may be physically located below or level with the opposing crank arm. For the purposes of this discussion, a crank system is in a "dead center position" when at least one of the tension vectors intersects the crank system axis.

Following a pause in exercise on a flexible element exercise device, the user will transfer weight from one foot support member to the other in order to initiate rotation of the crank system. However, the simple crank system shown in FIG. **1** has settled into a top dead center/bottom dead center position during the pause. Transfer of weight by the user now tensions flexible element **150**R. Tension vector **151**R intersects crank system axis **115**. Because there is no offset between tension vector **151**R and crank system axis **115**, there is no crank system torque generated by flexible element **150**R, and the crank system is in a locked condition.

FIG. **2** shows a side view of an example embodiment of a crank system for a flexible element exercise device. FIG. **2**A shows how the embodiment of FIG. **2** can be implemented in an example flexible element exercise device. Operational aspects of the FIG. **2**A type of exercise device are described in (US 2007/0219061 A1). The embodiment of FIG. **2** can be implemented in other configurations of flexible element exercise devices, and its use is not restricted only to the flexible element exercise device shown in FIG. **2**A. Crank arm **112**R is coupled to crank shaft **114**. Crank shaft **114** has an axis **115** that is also the crank system axis. Secondary crank arm **119** is rigidly coupled to crank arm **112**R at journal **118**. Crank arm **112**L is coupled to crank shaft **114**. Spring **108** is coupled to frame **101** and to secondary crank arm **117** at coupling location **107**. Coupling location **107** is selected so that it is offset from crank axis **115**. Flexible element **150**R is coupled to crank arm **112**R at journal **118**. Flexible element **150**L is coupled to crank arm **112** L. During a pause in exercise on the flexible element exercise device with one foot plate at its lowest resting position, the majority of force has been applied to one foot support member that has in turn tensioned flexible element **150**R. Spring **108** applies a force to secondary crank arm **119** and generates an offset torque in the crank system. The amount and location of the offset between coupling location **107** and crank axis **115** and the orientation and characteristics of spring **108** are specified by the designer of the machine so to achieve the desired offset torque when the crank system is at or near a dead center position. This torque displaces the crank system slightly during the pause and causes crank system offset between the tension vector **151** L and crank system axis **115**. Crank system lockup created by a top dead center condition is prevented.

FIG. **3** shows a side view of an example embodiment of a crank system for a flexible element exercise device. FIG. **3**A shows how the embodiment of FIG. **3** can be implemented in an example flexible element exercise device. Operational aspects of the FIG. **3**A type of exercise device are described in (US 2006/0217234 A1). The embodiment of FIG. **3** can be implemented in other configurations of flexible element exercise devices, and its use is not restricted only to the flexible element exercise device shown in FIG. **3**A. Crank arms **112**R and **112**L are coupled to crank shaft **114**. Flexible element

150R is coupled to crank arm **112**R at coupling location **117**R. Flexible element **150**L is coupled to crank arm **112**L at coupling location **117**L.

Many exercise devices are generally symmetric between the right and left sides, i.e. the left side is a mirror image of the right side. However, the embodiment of FIG. **3** has asymmetric guide elements **144**R and **144**L. Guide element **144**R is coupled to frame **101** and guides flexible element **150**R. Guide element **144**L is coupled to frame **101** and guides flexible element **150**L. Guide element **144**L is coupled to frame **101** at a location that is different than the mirrored location of guide element **144**R so that there is asymmetry in the locations of **144**R and **144**L. In other words, if a vertical plane is drawn along the machine center line when viewed from above and between guide elements **144**L and **144**R, the asymmetry of this example exists with respect to the plane. In various examples, asymmetry includes one guide element being higher vertically than the other and/or one guide element being closer to the front of the device than the other. The asymmetry is apparent when viewing the embodiment of FIG. **3** from the side.

During a pause in exercise on the flexible element exercise device with one foot plate at its lowest resting position, the majority of force has been applied to one foot support member that has in turn tensioned flexible element **150**R. Flexible element **150**R has pulled crank arm **112**R to a bottom dead center location in relation to crank axis **115**. As the user initiates exercise, weight is transferred to the opposing foot support member, and greater tension is created in flexible element **150**L. The asymmetric geometry of guide elements **144**R and **144**L causes crank system offset so that tension vector **151**L does not intersect crank system axis **115** at the moment of weight transfer. Thus, the tension in flexible element **150**L causes an offsetting torque that moves crank arms **112**R and **112**L, even though crank arm **112**R is in a bottom dead center position. Similarly, when crank arm **112**L rotates to a bottom dead center position, the asymmetry of guide elements **144**R and **144**L ensures that offsetting torque will allow the crank system to rotate. Crank system lockup created by a dead center condition is prevented.

FIG. **4** shows a side view of an example embodiment of a crank system for a flexible element exercise device. FIG. **4**A shows how the embodiment of FIG. **4** can be implemented in an example flexible element exercise device. Operational aspects of the FIG. **4**A type of exercise device are described in US 2007/0219061 A1. The embodiment of FIG. **4** can be implemented in other configurations of flexible element exercise devices, and its use is not restricted only to the flexible element exercise device shown in FIG. **4**A. The operation of the embodiment of FIG. **4** is similar to that of FIG. **3** in that the asymmetric geometry of guide elements **144**R and **144**L causes crank system offset. However, the embodiment of FIG. **4** provides for adjustment of the position of at least one of the guide elements. Guide element **144**L is attached to rocker mount **174**. Rocker mount **174** is pivotally coupled to frame **101**, and its position can be adjusted by servo/screw assembly **176**. Therefore, actuation of servo/screw assembly **176** changes the position of guide element **144**L. During a pause in exercise, guide element **144**L can be moved so as to create asymmetric geometry in relation to **144**R. After crank rotation is initiated, guide element **144**L can be moved to create symmetric geometry in relation to **144**L. Other embodiments include, additionally or alternatively, a mechanism for adjusting guide element **144**R. Repositioning of one or both guide elements can be done in a variety of automatic or manual methods as those skilled in the art will understand.

FIG. **5** shows a side view of an embodiment of an example crank system for a flexible element exercise device. FIG. **5**B shows how the embodiment of FIG. **5** can be implemented in an example flexible element exercise device. Operational aspects of the FIG. **5**B type of exercise device are described in US 2007/0219061 A1. The embodiment of FIG. **5** can be implemented in other configurations of flexible element exercise devices, and its use is not restricted only to the flexible element exercise device shown in FIG. **5**B. The embodiment of FIG. **5** has asymmetric guide element geometry, as in FIG. **3**, and the guide elements move with crank system rotation. Crank arm **112**R is coupled to crank shaft **114**. Secondary crank arm **119**R is rigidly coupled to crank arm **112**R at journal **118**R. Crank arm **112**L is coupled to crank shaft **114**. Secondary crank arm **119**L is rigidly coupled to crank arm **112**L at journal **118**L. Flexible element **150**R is coupled to crank arm **112**R at journal **118**R. Flexible element **150**L is coupled to crank arm **112**L at journal **118**L Flexible element **150**R engages guide element **144**R, and flexible element **150**L engages guide element **144**L. Guide element **144**R is coupled to and supported by support link **195**R. Support link **195**R is pivotally coupled near one end to frame **101** at location **196**. The other end of support link **195**R is coupled to the crank system by the engagement of support link **195**R with Roller **197**R, which is attached to secondary crank arm **119**R. Guide element **144**L is attached to and supported by support link **195**L. Support link **195**L is pivotally coupled near one end to frame **101** at location **196**. The other end of support link **195**L is coupled to the crank system by the engagement of support link **195**L with roller **197**L, which is attached to secondary crank arm **119**R. As the crank system rotates, rollers **197**R and **197**L cause support links **195**R and **195**L and guide elements **144**R and **144**L to undergo oscillating motion.

During a pause in exercise on the flexible element exercise device with one foot plate at its lowest resting position, the majority of force has been applied to one foot support member which has in turn tensioned flexible element **150**R. Flexible element **150**R has pulled crank arm **112**R near a bottom dead center location in relation to crank axis **115**. In this crank arm position, rollers **197**R and **197**L have positioned support links **195**R and **195**L respectively.

As the user initiates exercise, weight is transferred to the opposing foot support member and greater tension is created in flexible element **150**L. The position of support link **195**L and guide element **144**L causes crank system offset so that tension vector **151**L does not intersect crank system axis **115** at the moment of weight transfer. The tension in flexible element **144**L provides torque that causes crank arms **112**R and **112**L to rotate. Similarly, when crank arm **112**L rotates to a bottom dead center position, the asymmetry of guide elements **144**R and **144**L ensures that offsetting torque will allow the crank system to rotate. Crank system lockup created by a dead center condition is prevented. The embodiment shown in FIG. **5** has right and left support links with right and left guide elements. However, this embodiment can be configured to operate with only one support link as shown in FIG. **5**A. Support link **195** and its associated guide element **144**L undergo oscillation as the crank system rotates. Guide element **144** is stationary and supported by the frame **101**.

FIG. **6** shows a side view of an embodiment of a crank system for a flexible element exercise device. FIG. **6**A shows how the embodiment of FIG. **6** can be implemented in a flexible element exercise device. The embodiment of FIG. **6** can be implemented in other configurations of flexible element exercise devices, and its use is not restricted only to the flexible element exercise device shown in FIG. **6**A. Crank arms **112**R and **112**L are coupled to crank shaft **114**. Flexible element **150**R is coupled to crank arm **112**R at coupling location **117**R. Flexible element **150**L is coupled to crank arm **112**L at coupling location **117**L. Typical crank systems with two arms have symmetric mirrored geometry when viewed for the side, i.e. down the crank system axis, where the left crank arm is a mirror of the right crank arm and positioned at 180 degrees relative to the right crank arm with the crank system axis as the origin of angular measurement. The crank arms **112**R and **112**L and coupling locations **117**R and **117**L have asymmetric geometry wherein coupling location **117**R is not located at a 180 degree position in relation to coupling location **117**L.

During a pause in exercise on the flexible element exercise device with one foot plate at its lowest resting position, the majority of force has been applied to one foot support member which has in turn tensioned flexible element **150**R. Flexible element **150**L has pulled crank arm **112**L to a bottom dead center location in relation to crank axis **115**. As the user initiates exercise, weight is transferred to the opposing foot support member and greater tension is created in flexible element **150**R. The asymmetric geometry of the crank coupling locations causes crank system offset so that tension vector **151**R does not intersect crank system axis **115** at the moment of weight transfer. The offset in tension vector **151**R causes torque that rotates crank arms **112**R and **112**L. Similarly, when crank arm **112**R rotates to a bottom dead center position, the asymmetry of guide elements **144**R and **144**L ensures that offsetting torque will allow the crank system to rotate. Crank system lockup created by a top dead center condition is prevented.

FIG. **6**A shows a side view of an embodiment of a flexible element exercise device. Frame **101** includes a basic supporting framework including base **102**. The lower portion of base **102** engages and is supported by the floor. The crank system includes crank arm **112**R attached to crank shaft **114**. Only the right side elements in FIG. **6**A are numbered, but it is understood that there are opposing left side elements in this embodiment.

The crank system may also include and/or be coupled to a brake/inertia device, such as device **119**, coupled to the crank shaft. Alternately, a brake inertia device may be coupled to the crank shaft through a belt and pulley arrangement. Rotation of crank arms **112** about the axis of crank shaft **114** causes rotation of brake/inertia device **119**. Brake/inertia device **119** may provide a braking force that provides resistance to the user during exercise, and/or it may provide inertia that smoothes the exercise by receiving, storing, and delivering energy during rotation. Although the embodiment shown in FIG. **6**A uses a single brake/inertia device, it is possible to utilize multiple brake/inertia devices or to separate the braking and inertia functions between two or more devices.

A pivotal linkage assembly may include arcuate motion member **130**, and foot support member **134**, and support members **198** and **199**. Although only the elements of the right side pivotal linkage assembly are numbered, it is understood that there is a left side pivotal linkage assembly with comparable elements in this example. In the context of this specification, the term "member" includes a structure or link of various sizes, shapes, and forms. For example, a member may be straight, curved, or a combination of both. A member may be a single component or a combination of components coupled to one another. Arcuate motion member **130** has an upper portion **132**. Upper portion **132** can be used as a handle by the user. Arcuate motion member **130** may be straight, curved, or bent. Foot support member **134** has foot plate **136** on which the user stands. Foot support member **134** may be straight, curved, or bent. Foot support member **134** is coupled to arcuate motion member **130** at coupling location **138**. Foot support member **134** is also coupled to support member **199** at coupling location **139**. Coupling of the various members within the pivotal linkage assembly may be accomplished with a pivotal pin connection as shown in FIG. **6**A, but coupling may also be accomplished with any device that allows relative rotation between the arcuate motion member **130** and foot support member **134**. As used herein, the term "coupling" or "coupled" includes a direct coupling or an indirect coupling. Arcuate motion member **130** is coupled to frame **101** at coupling location **140**. Coupling may be accomplished with shaft and bushing as shown in FIG. **6**A, but coupling may also be accomplished with any device that allows rotation of arcuate motion member **130** relative to frame **101**. Support member **199** is coupled to support member **198** at location **194**, and support member **198** is coupled to frame **101** at location **141**.

As shown in FIG. **6**A, the portion of arcuate motion member **130** coupled to frame **101** is above the portion of arcuate motion member **130** coupled to foot support member **134**. In the context of this specification, one element is "above" another element if it is higher than the other element. The term "above" does not require that an element or part of an element be directly over another element. Conversely, in the context of this specification, one element is "below" another element if it is lower than the other element. The term "below" does not require that an element or part of an element be directly under another element.

The flexible support system includes flexible element **150**. Flexible element **150** may be a belt, a cog belt, a chain, a cable, or any flexible component able to carry tension. Flexible element **150** may have some compliance in tension, such as a rubber belt, or it may have little compliance in tension, such as a chain. At or near one end, flexible element **150** is coupled support members **198** and **199** at coupling location **194**. Coupling location **194** is also the location at which support member **198** is coupled to support member **199**. However, flexible element **150** may couple to either support member **198** or support member **199** at alternate locations such as **194***a* or **194***b*. At or near its other end, flexible element **150** couples to the crank system at coupling location **117**. Between its ends, flexible element **150** engages guide element **152** and guide element **144** located on arcuate motion member **130**. Guide elements **152** and **144** as shown in FIG. **6**A are pulleys, but they may be any other component that can guide and support a flexible element such as a cog belt pulley, a sprocket, a roller, or a slide block.

In this example, arcuate motion member **130** is oriented in a generally vertical position. In the context of this specification, an element is oriented in a "generally vertical" position if the element, as measured with respect to its connection points to other elements of the system considered within the range of motion for the element, tends to be closer to vertical than horizontal. It is not necessary that arcuate motion member **130** be straight, nor is it necessary that any portion be exactly vertical. Further, it is not necessary that the member be closer to vertical than horizontal at every moment during its use.

In this example, foot support member **134** may be oriented in a generally horizontal position. In the context of this specification, an element is oriented in a "generally horizontal" position if the element, as measured with respect to its connection points to other elements of the system considered within the range of motion for the element, tends to be closer to horizontal than vertical. It is not necessary that foot support member **134** be straight, nor is it necessary that any portion be exactly horizontal. Further, it is not necessary that the member be closer to horizontal than vertical at every moment during its use.

During operation, the user ascends the exercise device, stands on foot plates **136**, and initiates an exercising motion by placing his/her weight on one of foot plates **136**. As the user steps downward, force is transmitted through flexible support element **150** causing rotation of crank shaft **114** and brake/inertia device **119**. As crank shaft **114** continues to rotate, the effective length of the portion of the flexible element **150** as measured between guide element **144** and coupling location **194** continuously shortens and lengthens. As the above described effective length shortens, coupling location **194** moves closer to guide element **144** causing support members **198** and **199** to alter their relative geometry and thereby lift foot support member **134** and foot plate **136**. As crank rotation continues, the user may undertake a striding motion by applying a forward and/or rearward force to foot plates **136**. This striding motion results in displacement of foot plates **136** and foot members **134**. The combination of displacement of the foot plates **136** by the user and the continuous lifting and lowering of the foot plates through coupling to the crank system may result in a substantially closed path.

The length of the path is instantaneously controlled by the user according to the amount of forward or rearward force applied to foot plates **136**. If the user applies little rearward or forward force, the exercise path may be nearly vertical in orientation with little or no horizontal amplitude. Alternately, if the user applies significant rearward or forward force, the exercise path may have significant horizontal amplitude. Alternating weight transfer during exercise from one foot plate to the opposing foot plate transmits force to the crank **112** which sustains rotation of crank **112**, crank shaft **114**, and brake/inertia device **119**. Handles **132** may move in an arcuate pattern and may be grasped by the user.

If the user were to stand stationary on foot plates **136** for an extended period of time, a simple unweighted crank system might settle into a locked "top dead center" position. However, a crank system offset assembly prevents a top dead center lock up. In FIG. **6**A, the crank system offset assembly embodiment of FIG. **6** is implemented, but other embodiments of crank system offset assemblies may be used in the FIG. **6**A embodiment.

The right and left side pivotal linkage assemblies may be cross coupled through the left and right arcuate motion members so that the right and left foot plates **136** move in opposition. Elements **180** are coupled to arcuate motion members **130**. Thus, each of right and left elements **180** move in unison with each right and left arcuate motion member **130**, respectively. Connectors **182** couple right and left elements **180** to the right and left sides of rocker arm **184**. As arcuate motion members **130** move, connectors **182** cause a rocking motion of rocker arm **184**. This rocking motion causes right and left arcuate motion members **130** to move in opposition thus cross coupling the right and left pivotal linkage assemblies.

Additional braking systems may be included in the exercise device to resist horizontal movement of the foot plates. Brake **191** is coupled to the frame **101** and the rocker arm **184**. Brake **191** may be of several types such as frictional, electromagnetic, or fluidic. Rather than direct coupling of brake **191** to rocker arm **184**, brake **191** could be indirectly coupled to rocker arm **184** through a belt and pulley system. Brake **191** resists rocking motion of rocker arm **184** which in turn resists fore and aft motion of foot support member **134**.

FIG. **7** is an illustration of exemplary method **700** adapted according to one embodiment of the invention. Method **700** is a method of use for any of a variety of flexible element exercise devices, some of which are illustrated in FIGS. **2**-**6**A. In some embodiments, method **700** is performed by a user of an exercise device when a user ascends the device, descends from the device, or pauses during exercise.

In step **701**, one of the foot support members (either the left or right) is placed in a lowest resting position. Typically, when the first foot support member is in its lowest resting position, the second foot support member is in or near its highest resting position. The lowest resting position is often reached when a user applies more downward force to a first foot support member than to a second foot support member and then pauses the exercise effort.

In some embodiments, e.g., that of FIGS. **2** and **2**A, a crank offset system applies an offsetting torque to the crank system and prevents the system from settling into a dead center condition. As a user increases downward force on the second foot support member, the offsetting torque moves the crank system out of the dead center position and the first and second tension vectors do not intersect the axis of rotation of the crank system.

In other embodiments, e.g., that of FIGS. **3**-**6**A, the lowest resting position of the foot support member results in a configuration wherein one of the first and second tension vectors does not intersect the axis of rotation of the crank system. Since at least one tension vector does not intersect the axis of rotation, there is offsetting torque, thereby ensuring that the crank system can rotate.

In step **702**, a stepping or striding motion is applied to the right and left foot support members, thereby causing the crank system to rotate.

While method **700** is shown as a series of discrete steps, various embodiments may add, delete, modify, or rearrange various steps. For example, in one embodiment, a user exercises on a flexible element device and then pauses. During the pause, the user lets one of the foot support members reach its lowest resting position. The user then begins striding once the pause in exercise is over. Thus, the user performs step **702**, then step **701**, followed by step **702**. Moreover, the terms "lowest resting position" and "highest resting position" are used for convenience and, in some embodiments, may not literally refer to lowest or highest vertical geometric position of a foot support member only.

Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, and means described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, and means presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means.

What is claimed is:

1. An exercise apparatus allowing instantaneously variable striding motions, the exercise apparatus comprising:

a frame;

a crank system supported by the frame and adapted for continuous rotation, said crank system comprising a crank offset assembly configured to apply offset torque to the crank system when the crank system is in a dead center position;

a right foot support member coupled to the frame;

a left foot support member coupled to the frame;

a first flexible support system comprising:

a first flexible element, the first flexible element coupled to the right foot support member and the crank system and operative to rotate the crank system when the right foot support member moves downward; and

a second flexible support system comprising:

a second flexible element, the second flexible element coupled to the left foot support member and the crank system and operative to rotate the crank system when the left foot support member moves downward,

wherein force may be applied by a user to the right and left foot support members permitting the user to vary among a climbing motion and a closed path walking, striding, or jogging motion, the length of the walking, striding, or motion being instantaneously variable by the user as the user varies between a forward and rearward force applied to the foot support members.

2. The exercise apparatus of claim **1** wherein the crank offset assembly comprises first and second guide elements engaging first and second flexible elements respectively, the first guide element positioned asymmetrically relative to the second guide element.

3. The exercise apparatus of claim **2** wherein the first and second guide elements are positioned asymmetrically with respect to a vertical plane therebetween that is equidistant from both the first and second guide elements.

4. The exercise apparatus of claim **1** wherein the crank offset assembly comprises first and second guide elements engaging first and second flexible elements respectively, at least one guide element having adjustable positioning such that it can be positioned asymmetrically relative to the opposing guide element.

5. The exercise apparatus of claim **4** wherein adjustable positioning is controlled by a servo system.

6. The exercise apparatus of claim **5** wherein the guide element is attached to a rocker mount.

7. The exercise apparatus of claim **6** wherein the position of the rocker mount is controlled by a servo system.

8. The exercise apparatus of claim **1** wherein the crank system comprises a crank shaft and two crank arms.

9. The exercise apparatus of claim **1** wherein the right and left foot members are coupled to the frame through one or more linkage members.

10. The exercise apparatus of claim **1** comprising a brake/inertia system.

11. The exercise apparatus of claim **1** wherein the right and left foot support members are cross coupled by a cross coupling system to provide alternating motion.

12. The exercise apparatus of claim **11** above wherein the cross coupling system is coupled to a brake.

13. The exercise apparatus of claim **1** wherein the first and second flexible elements are selected from the list consisting of:

a belt;

a cog;

a chain; and

a cable.

14. The exercise apparatus of claim **1**, wherein the first flexible element engages a first plurality of guide elements, each in a different location;

and wherein the second flexible element engages a second plurality of guide elements, each in a different location.

15. An exercise apparatus allowing instantaneously variable striding motions, the exercise apparatus comprising:

a frame;

a crank system with an axis of rotation and adapted for continuous rotation, the crank system comprising first and second crank system coupling locations, the crank system supported by the frame;

a right foot support member comprising a right foot plate, the right foot support member coupled to the frame;

a left foot support member comprising a left foot plate, the left foot support member coupled to the frame;

a first flexible support system comprising a first flexible element operating in tension, the first flexible element coupled to the right foot support member and the first crank system coupling location, wherein a first tension vector defines a first direction of tension in the first flexible element near the first crank system coupling location;

a second flexible support system comprising a second flexible element operating in tension, the second flexible element coupled to the left foot support member and the second crank system coupling location, wherein a second tension vector defines a second direction of tension in the second flexible element near the second crank system coupling location; and

a crank offset assembly configured so that at least one of the tension vectors does not intersect the axis of rotation of the crank system when one of the right and left foot plates is at a lowest resting position,

wherein a user may apply a force to the foot support members so as to undertake a walking, striding, jogging, or climbing motion and may instantaneously alter the length of the walking, striding, or jogging motion by altering the forward and rearward force applied to the foot support members.

16. The exercise apparatus of claim **15** wherein the crank offset assembly comprises first and second guide elements engaging the first and second flexible elements respectively, the first guide element positioned asymmetrically relative to the second guide element.

17. The exercise apparatus of claim **16** wherein the first and second guide elements are positioned asymmetrically with respect to a vertical plane therebetween that is equidistant from both the first and second guide elements.

18. The exercise apparatus of claim **16** wherein an asymmetrical positioning of the first and second guide elements comprises:

a placement wherein the first and second guide elements have different vertical placements.

19. The exercise apparatus of claim **16** wherein an asymmetrical positioning of the first and second guide elements comprises:

a placement wherein one of the first and second guide elements is closer to a front end of the exercise apparatus than is the other.

20. The exercise apparatus of claim **15** wherein the crank offset assembly comprises:

first and second guide elements engaging the first and second flexible elements respectively, at least one of the guide elements having adjustable positioning such that the at least one guide element can be positioned asymmetrically relative to the opposing guide element.

21. The exercise apparatus of claim **20** wherein the adjustable positioning is controlled by a servo system.

22. The exercise apparatus of claim **20** wherein the at least one guide element is coupled to a rocker mount.

23. The exercise apparatus of claim 22 wherein a position of the rocker mount is controlled by a servo system.

24. The exercise apparatus of claim 15 wherein the crank system comprises a crank shaft and two crank arms.

25. The exercise apparatus of claim 15 wherein the foot member is coupled to the frame by one or more linkage members.

26. The exercise apparatus of claim 15 further comprising an item selected from the list consisting of:

a brake system; and

an inertia system.

27. The exercise apparatus of claim 15 wherein the right and left foot support members are cross coupled by a cross coupling system to provide alternating motion.

28. The exercise apparatus of claim 27 wherein the cross coupling system is coupled to a brake.

29. The exercise apparatus of claim 15 wherein the first and second flexible elements are selected from the list consisting of:

a belt;

a cog;

a chain; and

a cable.

30. The exercise apparatus of claim 15 wherein the first flexible element engages a plurality of guide elements, each in a different location;

and wherein the second flexible element engages another plurality of guide elements, each in a different location.

31. A method for operating an exercise apparatus, the exercise apparatus including a right foot support member coupled to a first flexible element operating in tension, said first flexible element coupled to a crank system at a first coupling location adapted for continuous rotation, wherein a first tension vector defines a direction of tension in the first flexible element near the first coupling location, and a left foot support member coupled to a second flexible element operating in tension, said second flexible element coupled to the crank system at a second coupling location, wherein a second tension vector defines a direction of tension in the second flexible element near the second coupling location, the method comprising:

placing one of the right and left foot support members in a lowest resting position, wherein one of the first and second tension vectors does not intersect an axis of rotation of the crank system when the lowest resting position is reached.

32. The method of claim 31 wherein one of the first and second tension vectors does intersect the axis of rotation of the crank system when the lowest resting position is reached.

33. The method of claim 31 further comprising:

applying a stepping or striding motion to the right and left foot support members, thereby causing the crank system to rotate.

34. A method for operating an exercise apparatus, the exercise apparatus including a right foot support member coupled to a first flexible element operating in tension, said first flexible element coupled to a crank system at a first coupling location, wherein a first tension vector defines a direction of tension in the first flexible element near the first coupling location, and a left foot support member coupled to a second flexible element operating in tension, said second flexible element coupled to the crank system at a second coupling location, wherein a second tension vector defines a direction of tension in the second flexible element near the second coupling location, the method comprising:

placing one of the right and left foot support members in a lowest resting position, wherein a crank offset mechanism coupled to said crank system applies offset torque to the crank system when the lowest resting position is reached.

35. The method of claim 34 further comprising:

applying a stepping or striding motion to the right and left foot support members, thereby causing the crank system to rotate.

36. An exercise apparatus allowing instantaneously variable striding motions, the exercise apparatus comprising:

a frame;

a crank system supported by the frame;

a right foot support member coupled to the frame;

a left foot support member coupled to the frame;

a first flexible support system comprising:

a first flexible element, the first flexible element coupled to the right foot support member and the crank system and operative to rotate the crank system when the right foot support member moves downward;

a second flexible support system comprising:

a second flexible element, the second flexible element coupled to the left foot support member and the crank system and operative to rotate the crank system when the left foot support member moves downward; and

a first guide element engaging the first flexible element and a second guide element engaging the second flexible element wherein at least one of the guide elements has adjustable positioning;

wherein a user may apply a force to the foot support members so as to undertake a walking, striding, jogging, or climbing motion and may instantaneously alter the length of the walking, striding, or jogging motion by altering the forward and rearward force applied to the foot support members.

37. The exercise apparatus of claim 36 wherein adjustable positioning is controlled by a servo system.

38. The exercise apparatus of claim 36 wherein the guide element is attached to a rocker mount.

39. The exercise apparatus of claim 36 wherein the position of the rocker mount is controlled by a servo system.

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